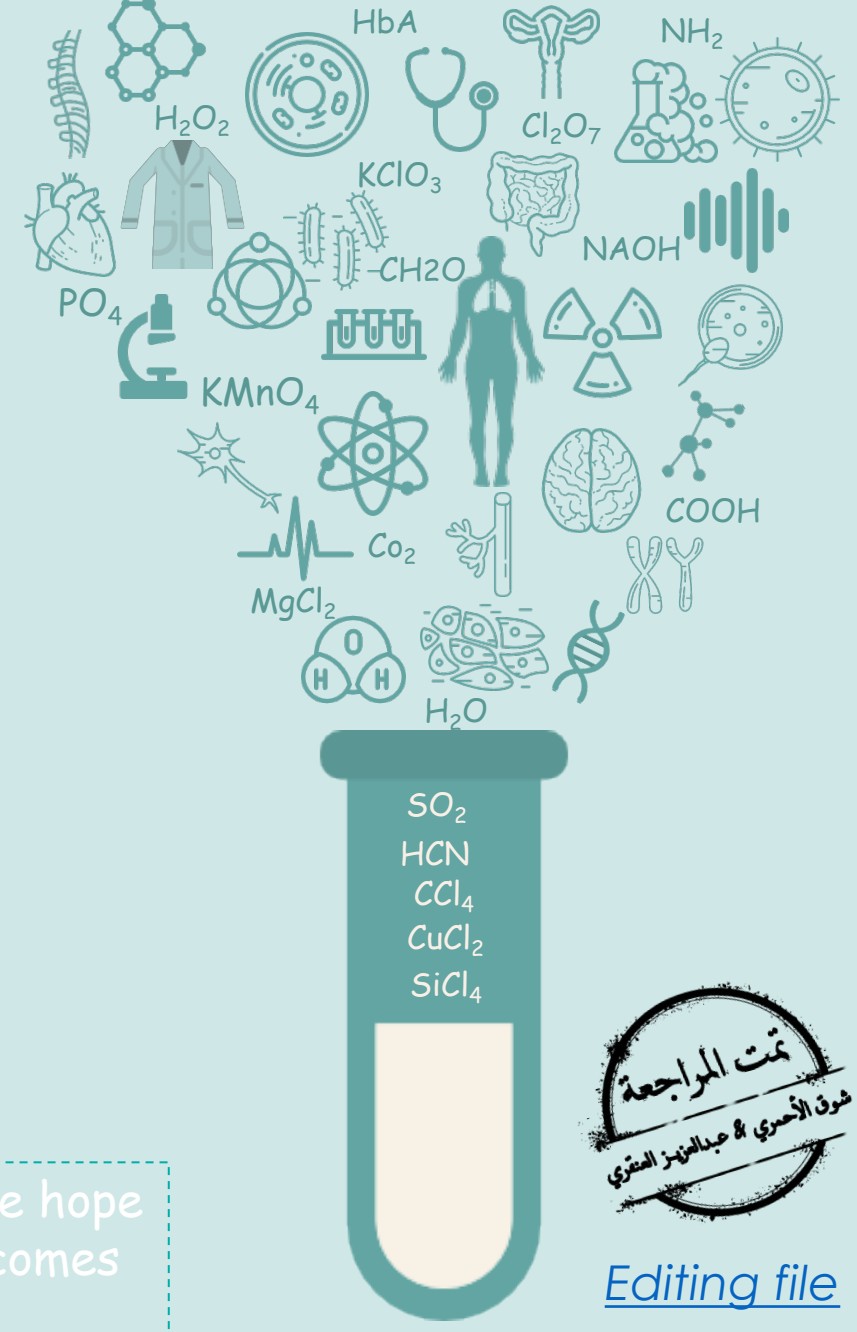


Important Doctors slides

Extra Information Doctors notes

Biochemistry

Macro and micro nutrients

When you choose hope every thing becomes possible

تمت المراجعة
شوق الأحمري & عبدالعزيز العنقري

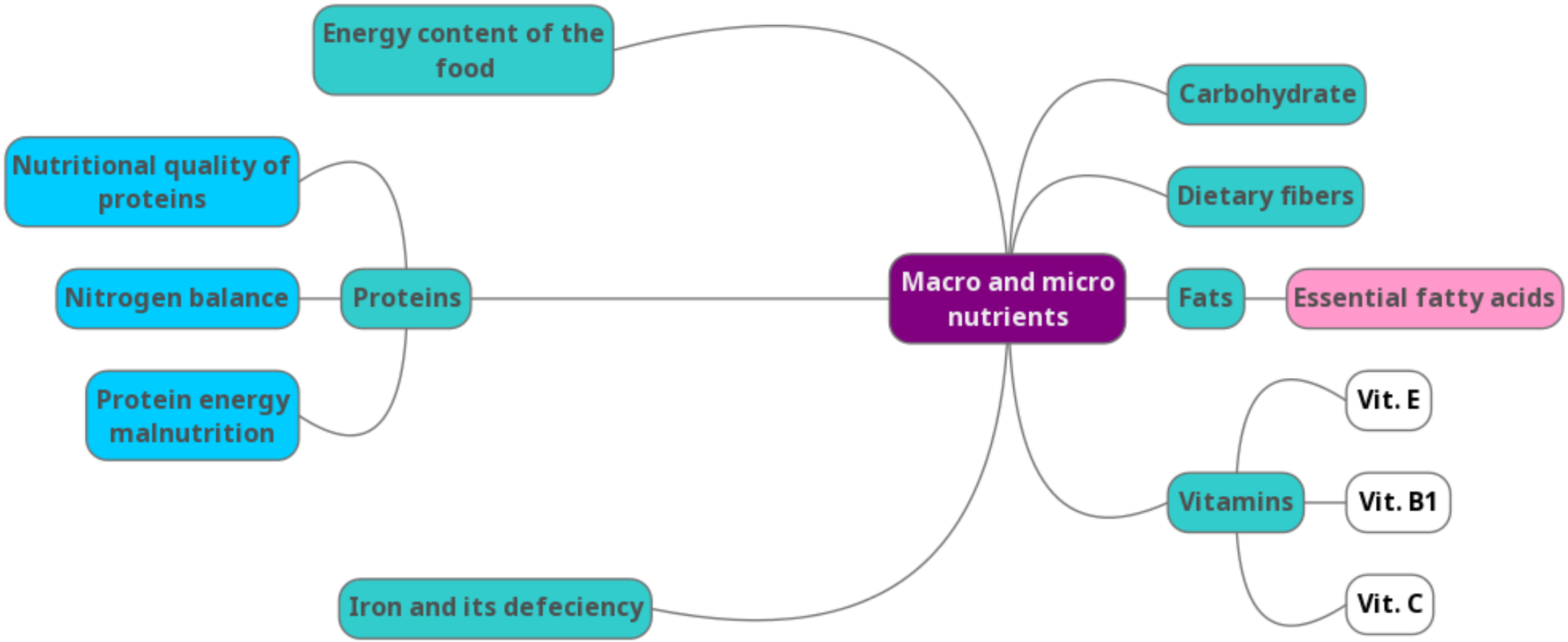
[Editing file]

OBJECTIVES

By the end of this lecture, the students should be able to know:

- Understand the nutritional importance of dietary macro and micronutrients
- Identify major dietary sources and RDAs of macro and micronutrients
- Evaluate the nutritional quality of proteins, the types of dietary carbohydrates, fibers and fats and their benefits
- Discuss the role of macronutrients in causing diseases or conditions such as nitrogen imbalance, diabetes, obesity, atherosclerosis and heart disease
- Understand the functions of micronutrients and the diseases due to their deficiencies

Lecture overview



Macronutrients & Micronutrients

Definitions :

- **1) Macronutrients:** Nutrients needed by the body in large amounts (proteins, carbohydrates, fats)
- They provide energy and building blocks for proteins, carbohydrates and fats that are stored.

- **2) Micronutrients:** Nutrients needed by the body in small amounts (vitamins, minerals, trace elements) (Micro=small amounts)
- ✓ Required for maintaining normal health and preventing various diseases
- ✓ They do not provide energy
- ✓ A lot of them work as coenzymes and cofactors supporting the biochemical reactions.

Energy Content of Food: Calories	Body obtains energy as ATP
	The energy content of food is measured in calories (Kilocalories)
	One calorie is the heat required to raise the temperature of 1 gm. of water by 1°C Proteins → 4 kcal/gm Carbohydrates → 4 kcal/gm Fat → 9 kcal/gm

Colorimeter is the instrument used for measuring calories.
-Proteins are not easily digested so avoid taking them in large amounts.
-Carbohydrates are the best source of energy.
-Fats are the most concentrated form of energy, and they have harmful effect if you take them in large amounts.
What does (9 kcal/gm) mean?
It means that if you burn 1 gm of fat, 9 kcal are produced.

Energy Content Of Food

- Acceptable Macronutrient Distribution Range (ADMR)
- Adequate intake of macronutrients to prevent the risk of disease.

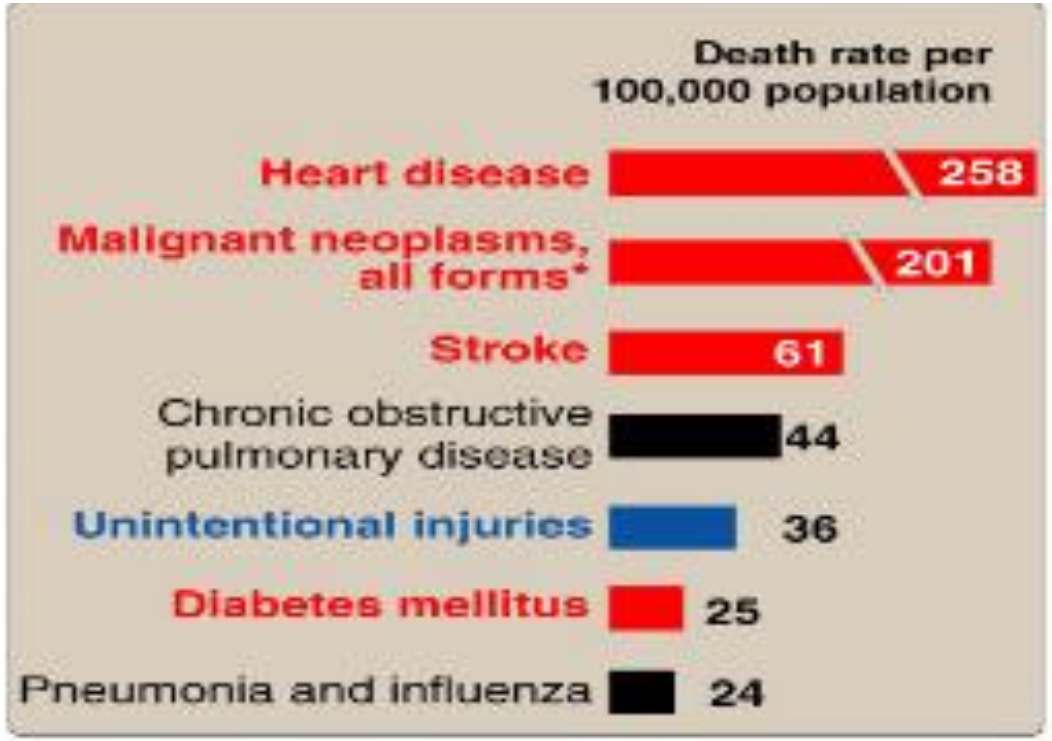


Figure 27.8
Influence of nutrition on some common causes of death in the United States in the year 2000. Red indicates causes of death in which the diet plays a significant role. Blue indicates causes of death in which excessive alcohol consumption plays a part. (*Diet plays a role in only some forms of cancer.)

AMDR for adults:
CHOs: 45-65%
Proteins: 10-35%
Fats: 20-35%

These percentages are how they should be distributed in your diet.

Death rate per 100,000 population due to imbalanced nutrition (main cause)
Unintentional injuries are caused by alcohol as well.
These rates show the effect of imbalanced diet, so it makes you at a high risk of heart diseases, cancer, stroke and diabetes.

1- Proteins

Nutritional Importance of Proteins:

✓Proteins supply amino acids and amino nitrogen for the body

✓Non-essential amino acids: body can synthesize

*Pneumonic: PVT TIM HALL

Essential amino acids: Body can't synthesize, must be supplied in the diet.
This is the most important benefit of proteins.

- Phenylalanine
  - Valine
- Tryptophan
  - Threonine
- Isoleucine
  - Methionine
- Histidine
  - Arginine
- Lysine
  - Leucine

If you take too much proteins they won't be stored as proteins and could be stored as fat.

Nutritional Quality of Proteins:

❖ What is it ?

✓A measure of a protein's ability to provide the essential amino acids required for tissue maintenance.
✓Measured in PDCAAS units. (Digestibility-Corrected Amino Acid Scoring)

✓High value indicates more digestibility and high quality. (maximum score 1.0 > the more the number the higher the quality.)

✓Proteins from animal sources which is a very good protein : 0.82–1.0 (milk has score of 1)
✓Proteins from plant sources: 0.4

Sources and RDA:

➢ Meat, poultry, fish, milk (have digestibility score of 1.0), wheat, corn, beans, nuts .

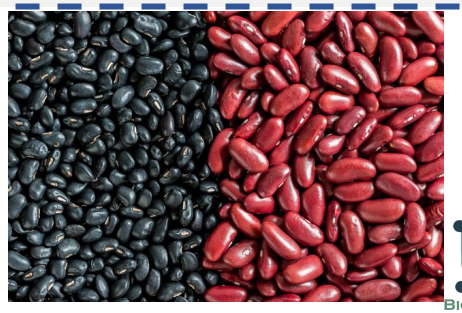
❖ RDA (gms/kg body weight)
- ✓ Normal adults: 0.8
- ✓ Athletes: 1.0
- ✓ Pregnancy / lactation: upto 30 gm
- ✓ Children: 2.0 They need more because they're growing up.

- Don't go into details for PDCAAS measurement.
- A lot of proteins are not easily digested, so a good quality protein would be a protein that is easily digested **and** has the essential amino acids.
- You can have combinations of of plant sources in order to make it as good as animal sources.

For example: wheat is rich in methionine and poor in lysine, both are essential amino acids, on the other side, kidney beans are rich in lysine and poor in methionine, if you combine these two you'll get better quality proteins.

Don't memorize the RDA numbers because they depend on the weight.

EXTRA: black beans vs. kidney beans



Nitrogen balance

Nitrogen Balance

Nitrogen balance = how much nitrogen going inside the body as proteins and how much nitrogen excreted (mainly as ammonia)

Normal Nitrogen Balance:

In a healthy person, the nitrogen intake is equal to nitrogen loss, but that doesn't mean that proteins are taken and excreted equally.

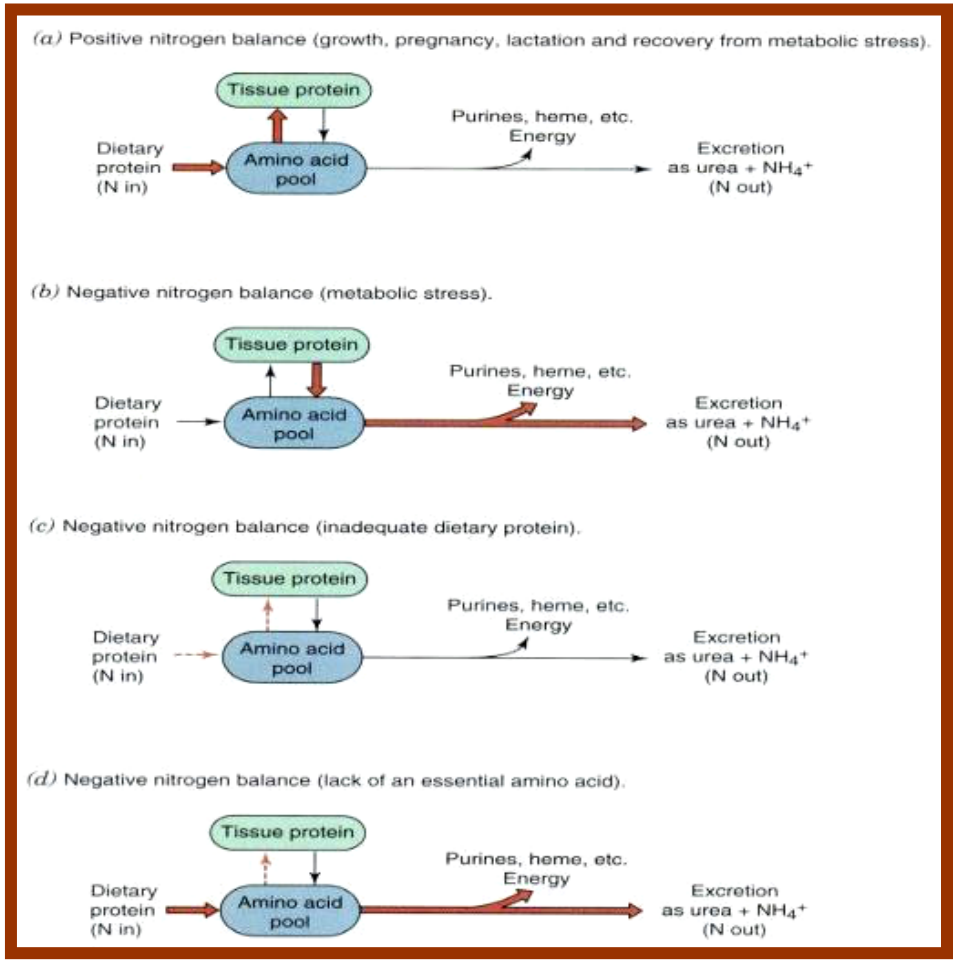
Negative nitrogen balance:

When nitrogen loss is more than intake

Occurs in burns, trauma, illness, metabolic stress which cause an abnormal loss, or if proteins in diet are not sufficient.

Positive nitrogen balance:

- When nitrogen intake is more than loss
- Occurs in growth, pregnancy, lactation, recovery from illness. So you're storing proteins.



Metabolic stress means increased catabolism.
In point d: proteins have less essential amino acids so they're less qualified, so the excretion will be high because we don't need these proteins.

Protein-Energy Malnutrition

❖ What is it?

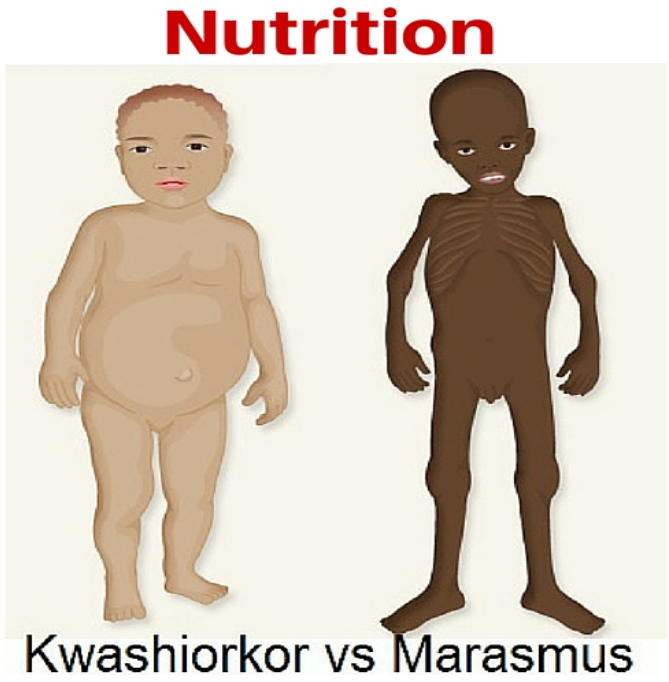
❖ A condition or disease caused by not eating enough food or not eating a balanced diet.

✓ Malnutrition due to inadequate intake of proteins or energy.

✓ **Two conditions:**

1. Marasmus
2. Kwashiorkor

Both conditions affect young children and are caused by protein malnutrition.



Kwashiorkor vs Marasmus

Protein-Energy Malnutrition

	Marasmus	Kwashiorkor
Cause	Inadequate intake of energy with adequate protein intake They start breaking down proteins (by using amino acids in gluconeogenesis) because they don't have adequate source of energy.	Inadequate intake of proteins with adequate energy intake
Age and food intake	✓ 1-3 year ✓ Mother's milk is supplemented with food (cereals) deficient in calories	✓ After weaning (at about 1 year) (few months to 1 year) ✓ Diet mainly contains CHOs They don't get enough proteins from milk because their mothers stopped feeding them (sometimes because they're poor) so they only get CHO rich food.
Symptoms	✓ Arrested growth ✓ Extreme muscle wasting ✓ Weakness ✓ Weight loss ✓ No edema or changes in plasma proteins, because protein intake is enough.	✓ Edema ✓ Distended abdomen ✓ Diarrhea ✓ Dermatitis / thin hair ✓ Enlarged fatty liver (due to excess of CHO) ✓ Low plasma albumin (because there isn't proteins)

2- Carbohydrates

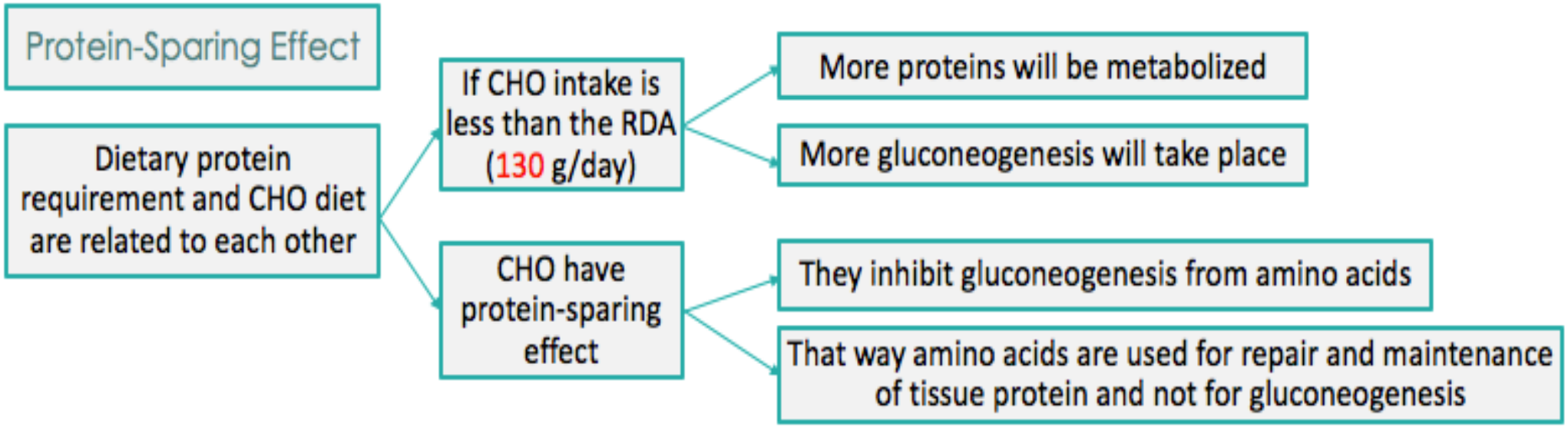
✓**Their major role:** energy production

✓**RDA:** 130 grams/day for adults and children

✓**Types in the diet:**

- ➢Simple CHOs: sucrose, fructose, lactose, corn syrup
- ➢Complex CHOs: whole grains, pasta, wheat, starch

✓CHO intake above RDA causes weight gain or obesity due to increased fat storage in adipose tissue.
(CHO is turned into fat)



RDA = Recommended dietary allowance.
When the body isn't getting enough carbs, it turns to proteins and breaks them down to get energy.

Dietary Fiber

❖ What is it?

- The component of food that cannot be broken down by human digestive enzymes

➢ **RDA (gm/day):** Men: 38, Women: 25

How they lower LDL levels:

Bile salts are not normally excreted outside the body, they are produced for the digestion of lipids then get reabsorbed.

So dietary fibers bind to bile salts which are made of cholesterol, and excrete them out of the body, which leads to making new bile salts out of carbohydrates.

We have two types of fibers:

1) Soluble fibers: bind to bile salts, they can destroy carcinogens.

2) Insoluble fibers: help in motility and diarrhea.

Benefits

✓Lowers serum LDL levels

✓Reduces constipation

✓Promotes feeling of fullness

✓Slows gastric emptying (helpful in long-term glucose control in patients with diabetes mellitus)

✓Reduces exposure of gut to carcinogens

Fats in diet

- A concentrated source of energy (9 kcals/gram)
- Supply essential fatty acids such as linoleic and linolenic acids*
- Provide phospholipids for membrane function
- Source of fat-soluble vitamins (A, D, E, K) and help in their absorption

RDA (gm/day)	Total fats: 65 gm Saturated: 20 gm	Excessive fat intake can cause: Atherosclerosis/heart disease Obesity

*Which give rise to eicosanoids that provide thromboxane and prostaglandins > play a role in inflammation (they have cardio-protective function)

Essential Fatty Acids

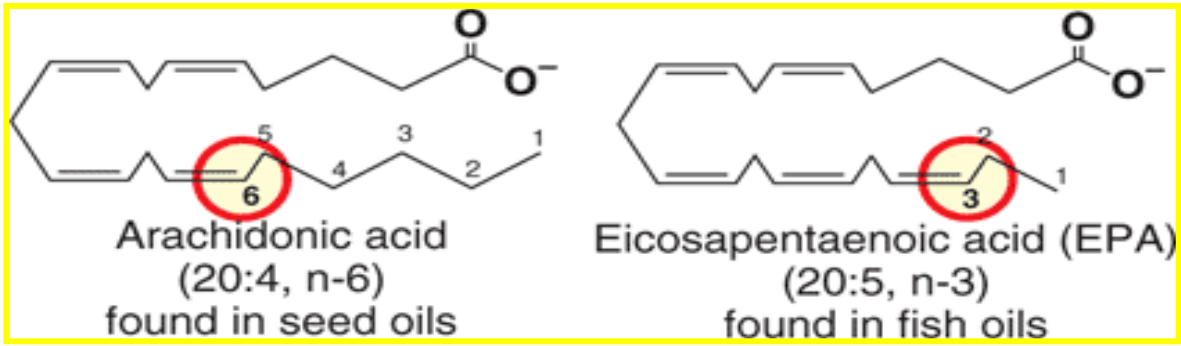
Two essential fatty acids – unsaturated :

- a-linolenic acid (w-3 fatty acid)*
- linoleic acid (w-6 fatty acid)

✓Deficiency causes: scaly skin, dermatitis, reduced growth (most common in infants)

✓Used for eicosanoids synthesis which appear to have cardio-protective effects

- decrease blood clotting
- decrease blood pressure



*w = omega, w-3 = the first double bond is present in carbon number 3.

Essential Fatty Acids

Omega-3 Fatty Acids

✓ **Sources**

- Plants
- Fish oil containing docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA)

✓ **Play an important role as:**

- Structural membrane lipids
- Modulator of w-6 fatty acid metabolism

Effects

- Suppress cardiac arrhythmias
- ↓ Serum triacylglycerol
- ↓ Tendency to thrombosis
- Lower blood pressure
- ↓ Risk of cardiovascular mortality
- Little effect on LDL or HDL levels

Recommendations for Omega-3 Fatty Acid Intake

By American Heart Association Guidelines

1. Patients without coronary heart disease (CHD) but are at risk of developing it

- Fatty fish twice a week
- Include oils and foods rich in a-linolenic acid (flaxseed, canola and soybean oils; flaxseed and walnuts)

2. Patients with Chronic Heart Disease

- 1 gm of EPA+DHA per day from fatty fish
- EPA+DHA supplements

3. Patients who need to lower triglycerides (fats) and have CHD

- 2 to 4 grams of EPA+DHA per day

CHD = Coronary heart diseases.
EPA = Ecosapentaenoic acid.
DHA = Docosahexaeonic acid.

Essential Fatty Acids

Omega-6 Fatty Acids

✓ **Sources**

1. Nuts
2. Avocados
3. Olives
4. Soybeans
5. Oils (sesame, cottonseed, corn oil)

✓ **Effects**

- ↓ Plasma cholesterol
- ↓ LDL
- ↓ HDL , considered as a negative effect, but it can be compensated.

Trans Fatty Acids

❖ **What is it?**

- Unsaturated fatty acids, behaving more like saturated fatty acids in the body.
  - ➢ **increase** serum LDL (but not HDL)
  - ➢ risk of CVD

✓ Not found in plants (animals only)

✓ Formed during hydrogenation of liquid vegetable oils

✓ Found in baked food: cookies, cakes, deep-fried foods

They are harmful, much easier to be oxidized and cause thrombosis.

1- Vitamins

- Organic compounds present in small quantities in different types of food

✓Help in various biochemical processes in cell

✓Important for growth and good health

✓Essential

✓Noncaloric

✓Required in very small amounts, so they are micronutrients.

Classified Based on Solubility

Fat-soluble vitamins

- A,D,E and K

Mnemonic: KADE (Name of a girl)

Water-soluble vitamins

- ascorbic acid (vitamin C)
- thiamin (vitamin B1)
- riboflavin (vitamin B2)
- Niacin (Vitamin B3)
- pyridoxine (vitamin B6)
- biotin
- pantothenic acid
- folate
- cobalamin (vitamin B12)

Vitamin E

Antioxidant: prevents oxidation of cell components by molecular oxygen and free radicals

✓May have a role in fertility and anti-aging effect

✓a-Tocopherol is the most active form in the body

❖ **Sources and RDA (mg/day):**

➢Vegetable Oil, nuts, seeds, vegetables

➢Adults: 15 mg , Children: 7mg

❖ **Deficiency:** (mostly observed in premature infants)

- Defective lipid absorption
- Anemia due to oxidative damage to RBCs.
- Neurological problems
- Male infertility

Functions of Vitamin B1 (Thiamin)

❖ Active form:

✓ Thiamin pyrophosphate (TPP)

❖ Coenzyme for transketolase (in HMP pathway) and oxidative decarboxylation reactions

❖ **In thiamin deficiency**, the activity of these two dehydrogenases is decreased
Causing : Low ATP production and defective cellular function

- **Sources and RDA** (mg/day)
  - ➢ Plants, cereals, meat
  - ➢ Adults: 1.2mg , Children: 0.6 mg

Disorders of Vitamin B1 (Thiamin) Deficiency

1. **Beriberi :** A type of chronic peripheral neuritis due to severe thiamin deficiency causes weakness, neuropathy, disorderly thinking, paralysis
   - Thiamin has a role in nerve conduction
   - Neuropathy affects glial cells (astrocytes) of the brain and spinal cord causing neuron death

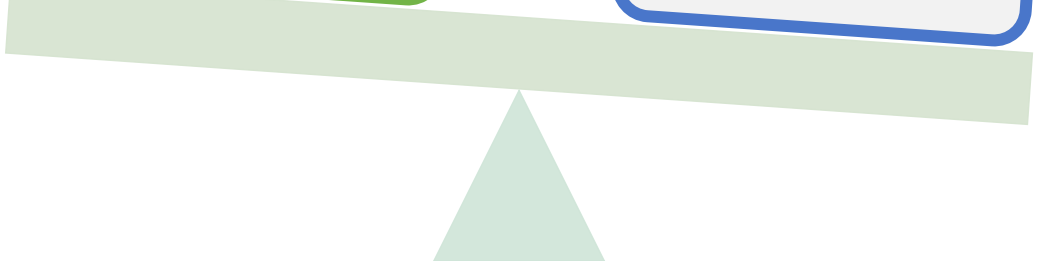
2. **Wernicke-Korsakoff syndrome**
Common in alcoholics* due to defective intestinal absorption of thiamin or dietary insufficiency
Causes apathy, loss of memory

*Because alcoholics don't absorb vitamins properly.

Vitamin C

Functions :

- Powerful antioxidant (prevents some cancers)
- Helps in dentine, intercellular matrix and collagen formation*
- Helps in the maturation of RBCs
- Promotes wound healing
- Reduces risk of cataract formation
- Increases iron absorption**
- Stimulates phagocytic action of leukocytes***



❖ **Sources and RDA** (mg/day):

- Citrus fruits, tomatoes, melon, peppers
- Men: 90 mg , Women: 75 mg , Children: 15-25 mg

Disorders of Vitamin C Deficiency

➢ Scurvy
- ✓ Abnormal collagen production
- ✓ Gums become painful, swollen and spongy
- ✓ The pulp is separated and the teeth are lost

*So it's the ground substance.
**That's why it's recommended when a person is on iron supplementation (specially as orange juice.
***Increases immunity.

2,3- Minerals and Trace Elements

Macro minerals :

(More than100 mg/day)

1. Calcium
2. Phosphorous
3. Sodium
4. Potassium
5. Chloride
6. Magnesium

Micro minerals :

(Less than100 mg/day)

1. Iron
2. Iodine
3. Copper
4. Manganese
5. Zinc
6. Cobalt
7. Molybdenum
8. Selenium
9. Fluoride
10. Chromium
11. Silicon

Iron

Functions:

1. Oxygen transport and metabolism
2. Part of hemoglobin, myoglobin, cytochromes
3. Body stores iron as ferritin, hemosiderin and transferrin
4. Adult women have much lower iron storage than men

Hemosiderin: a complex of ferritin.
Transferrin: a transporter.

- **Sources and RDA** (mg/day):

Heme iron: Animal products (meat, liver), 25% absorption	Non-heme iron: Plants (spinach, beans) 5% absorption	Men: 8 mg , Women: 18 mg , Children: 7-15 mg

Iron Deficiency:

- Iron deficiency anemia is most common
  - ✓ Growing children, pregnant, lactating and menstruating women need more iron

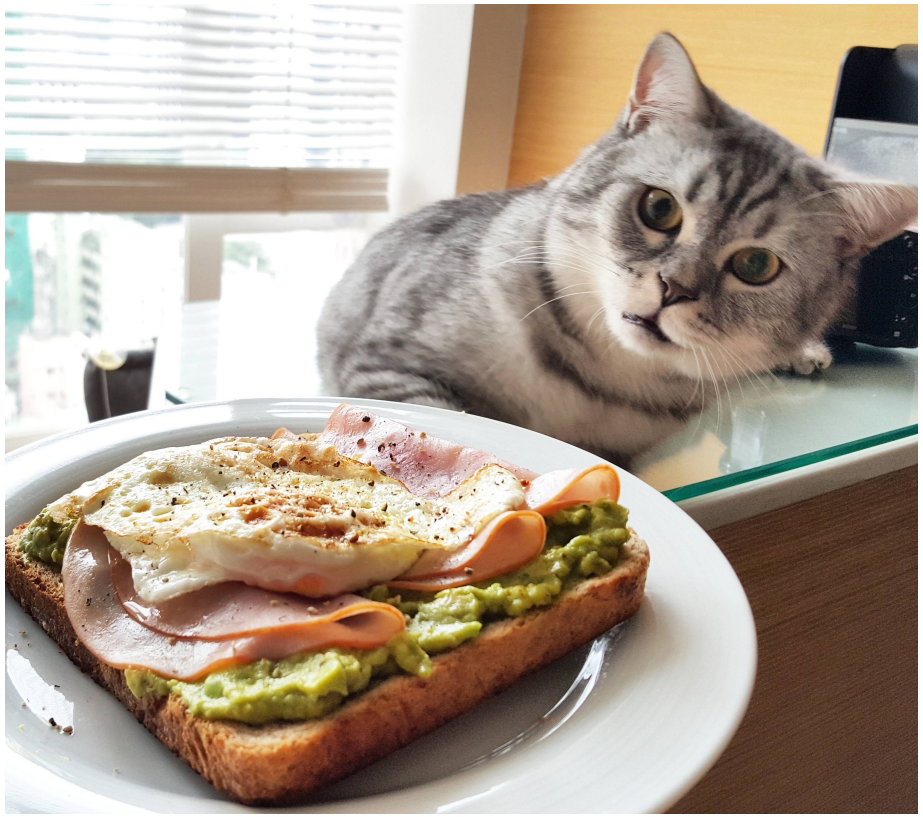
- Hemosiderosis (iron overload disorder)
  - ✓ Due to iron excess (toxicity)
  - ✓ Hemosiderin (Iron stored in complex with ferritin protein in liver and spleen)
  - ✓ Occurs in persons receiving repeated blood transfusions

Iron overload disorder is caused by multiple transfusions of blood.

Take home messages

✓Macro and micronutrients are essential for energy and maintaining good health

✓Various diseases are associated either with malnutrition or excessive intake of these nutrients



QUIZ

Q1 : Which of the following is a protein source ?

A- Milk
B- Fish
C- Carrot
D- Both A & B

Q2 : Omega-3 fatty acid is mainly found in ?

A- Ocean fish
B- Insects
C- Hot water
D- Both A & B

Q3 : Vitamins are ?

A- Caloric
B- Required daily with large amounts
C- Essential
D- Both B & C

Q4 : Wernicke-Korsakoff syndrome is due to deficiency in which of the following enzymes ?

A- Vitamin B12
B- Vitamin C
C- Vitamin A
D- Vitamin B1

Q5 : Iron is considered as ?

A- Micromineral
B- Macromineral
C- Semi-macromineral
D- Non of the above

Q6 : Iron deficiency anemia is common in ?

A- Breastfeeding women
B- Pregnant women
C- Adults
D- Newborns

QUIZ

Q7 : Mention two conditions associated with inadequate protein intake ?

1. Marasmus
2. Kwashiorkor

Q8 : Mention three functions of Vitamin C ?

1. Increases iron absorption
2. Powerful antioxidant (prevents some cancers)
3. Promotes wound healing

Q9 : Mention two benefits of dietary fibers ?

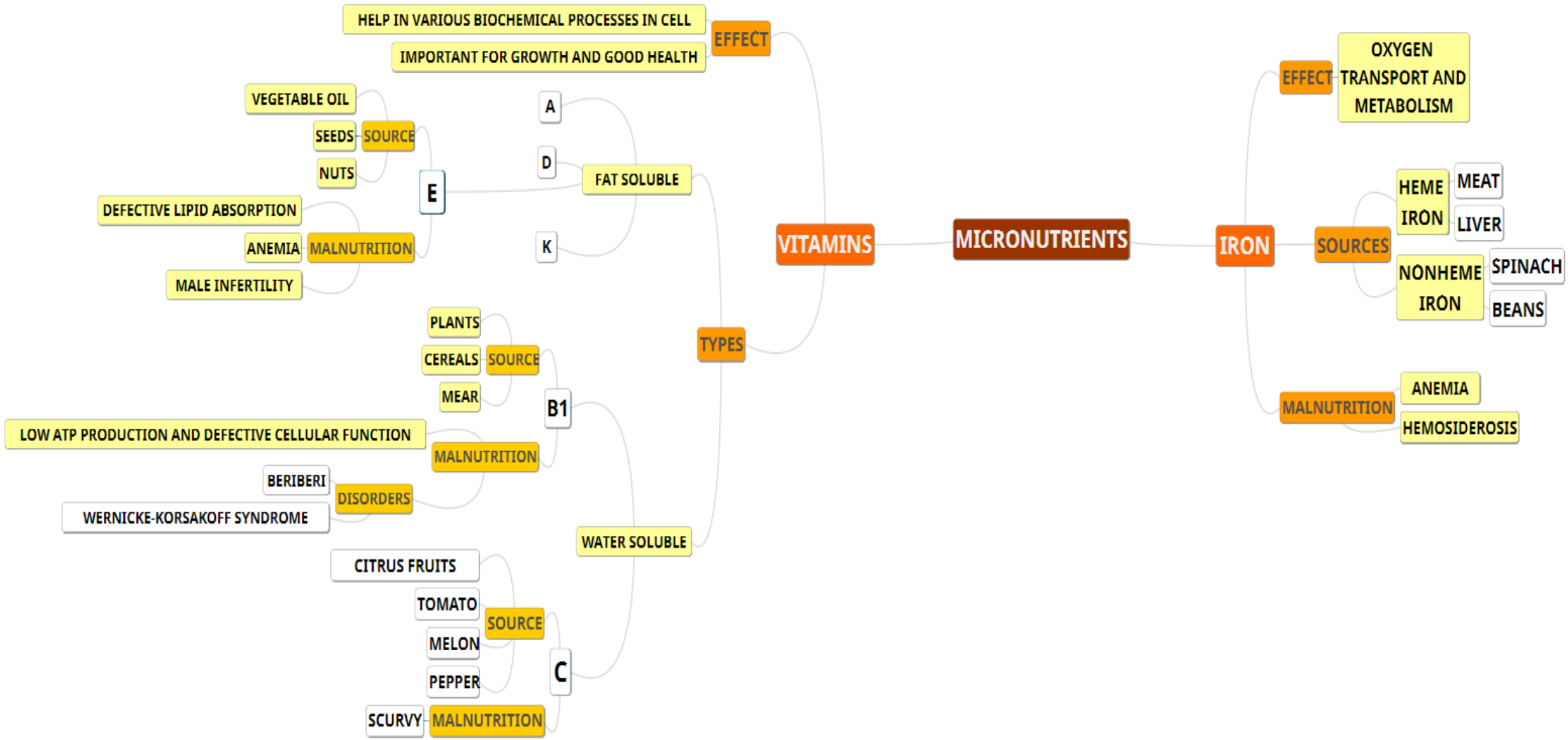
1. Lowers serum LDL levels
2. Reduces constipation
3. Promotes feeling of fullness
4. Slows gastric emptying (long-term glucose control in patients with diabetes mellitus)
5. Reduces exposure of gut to carcinogens

Suggestions and recommendations

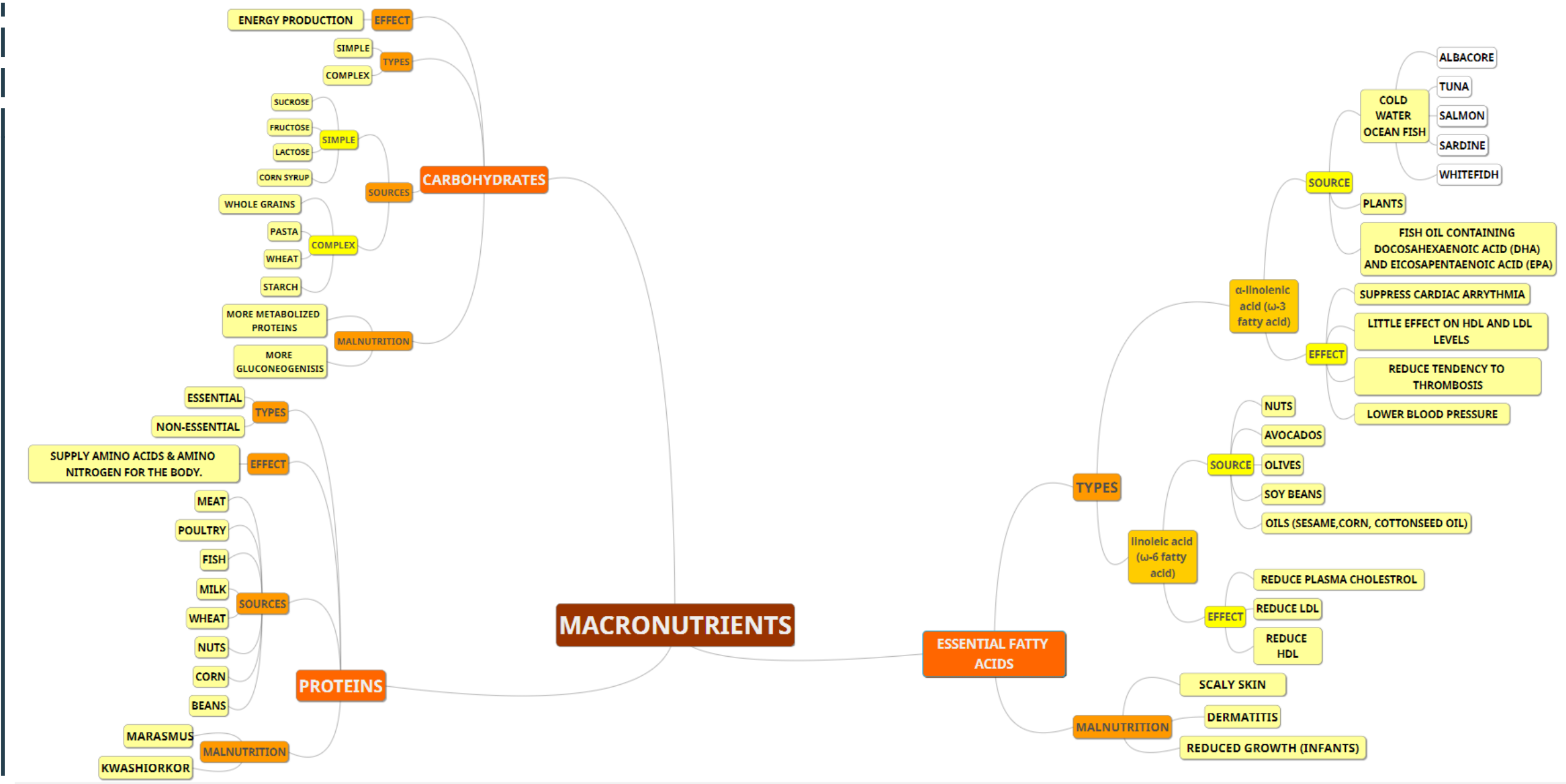
1) D 2) A 3) A 4) D 5) A 6) B

Biochemistry Team 436

SUMMARY


MICRONUTRIENTS
VITAMINS
EFFECT
HELP IN VARIOUS BIOCHEMICAL PROCESSES IN CELL
IMPORTANT FOR GROWTH AND GOOD HEALTH
TYPES
FAT SOLUBLE
A
D
E
K
SOURCE
VEGETABLE OIL
SEEDS
NUTS
MALNUTRITION
DEFECTIVE LIPID ABSORPTION
ANEMIA
MALE INFERTILITY
WATER SOLUBLE
B1
SOURCE
PLANTS
CEREALS
MEAR
MALNUTRITION
LOW ATP PRODUCTION AND DEFECTIVE CELLULAR FUNCTION
DISORDERS
BERIBERI
WERNICKE-KORSAKOFF SYNDROME
C
SOURCE
CITRUS FRUITS
TOMATO
MELON
PEPPER
MALNUTRITION
SCURVY
IRON
EFFECT
OXYGEN TRANSPORT AND METABOLISM
SOURCES
HEME IRON
MEAT
LIVER
NONHEME IRON
SPINACH
BEANS
MALNUTRITION
ANEMIA
HEMOSIDEROSIS

SUMMARY


MACRONUTRIENTS
CARBOHYDRATES
EFFECT
ENERGY PRODUCTION
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SIMPLE
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SIMPLE
SUCROSE
FRUCTOSE
LACTOSE
CORN SYRUP
COMPLEX
WHOLE GRAINS
PASTA
WHEAT
STARCH
MALNUTRITION
MORE METABOLIZED PROTEINS
MORE GLUCONEOGENISIS
PROTEINS
TYPES
ESSENTIAL
NON-ESSENTIAL
EFFECT
SUPPLY AMINO ACIDS & AMINO NITROGEN FOR THE BODY.
SOURCES
MEAT
POULTRY
FISH
MILK
WHEAT
NUTS
CORN
BEANS
MALNUTRITION
MARASMUS
KWASHIORKOR
ESSENTIAL FATTY ACIDS
TYPES
α-linolenic acid (ω-3 fatty acid)
SOURCE
COLD WATER OCEAN FISH
ALBACORE
TUNA
SALMON
SARDINE
WHITEFIDH
PLANTS
FISH OIL CONTAINING DOCOSAHEXAENOIC ACID (DHA) AND EICOSAPENTAENOIC ACID (EPA)
EFFECT
SUPPRESS CARDIAC ARRYTHMIA
LITTLE EFFECT ON HDL AND LDL LEVELS
REDUCE TENDENCY TO THROMBOSIS
LOWER BLOOD PRESSURE
linoleic acid (ω-6 fatty acid)
SOURCE
NUTS
AVOCADOS
OLIVES
SOY BEANS
OILS (SESAME,CORN, COTTONSEED OIL)
EFFECT
REDUCE PLASMA CHOLESTROL
REDUCE LDL
REDUCE HDL
MALNUTRITION
SCALY SKIN
DERMATITIS
REDUCED GROWTH (INFANTS)

TEAM LEADERS

Mohammad Almutlaq

Rania Alessa

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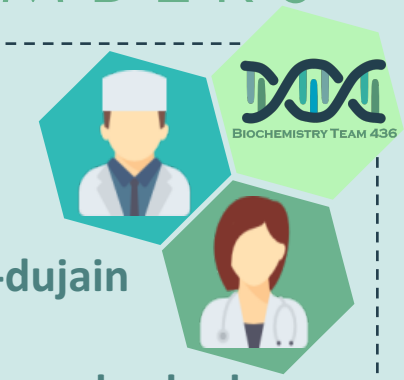

Naser abu-dujain

Abdulrahman alrashed

Heba Alnasser

Rana barasain

THANK YOU

FOR CHECKING OUR WORK

PLEASE CONTACT US IF YOU HAVE ANY ISSUE

- Lippincott's Illusrated Reviews Biochemistry 6th E

Review the notes

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